5. Use the exponent law for a power of a quotient.

a) $(8 \div 5)^3 = 8^3 \div 5^3$

b) $(21 \div 5)^4 = 21^4 \div 5^4$

c) $[(-12) \div (-7)]^5 = (-12)^5 \div (-7)^5$

d) $\left(\frac{10}{3}\right)^3 = \frac{10^3}{3^3}$

e) $\left(\frac{1}{3}\right)^2 = \frac{1^2}{3^2}$

f) $\left(\frac{27}{100}\right)^4 = \frac{27^4}{100^4}$

10. a) I multiplied in the brackets first, because it was easier than using the power of a product law. Then I evaluated the power:

$(3 \times 2)^3 = 6^3$

$= 216$

b) I multiplied in the brackets first, because it was easier than using the power of a product law. Then I evaluated the power:

$[(-2) \times 4]^2 = (-8)^2$

$= 64$

c) I divided in the brackets first, because it was easier than using the power of a quotient law. Then I evaluated the power:

$\left(\frac{9}{-3}\right)^3 = (-3)^3$

$= -27$

d) I divided in the brackets first, because it was easier than using the power of a quotient law. Then I evaluated the power:

$\left(\frac{8}{2}\right)^2 = 4^2$

$= 16$

e) I used the zero exponent law:

$(12^8)^0 = 1$

f) I used the power of a power law, then a calculator:

$[(-4)^2]^2 = (-4)^4$

$= 256$

14. Use the exponent laws to simplify first

b) $(4^6 \div 4^4)^2 = (4^{6-4})^2$ Use the exponent law for quotients.
$= (4^2)^2$ Use the power of a power law.
$= 4^{2 \times 2}$ Multiply the exponents.
$= 4^4$
$= 256$

d) $(10^6 \div 10^4)^3 = (10^{6-4})^3$ Use the exponent law for quotients.
$= (10^2)^3$ Use the power of a power law.
$= 10^{2 \times 3}$ Multiply the exponents.
$= 10^6$
$= 1\ 000\ 000$

f) $(12^2)^4 \div (12^3)^2 = 12^{2 \times 4} \div 12^{3 \times 2}$ Use the power of a power law.
$= 12^8 \div 12^6$ Use the exponent law for quotients.
$= 12^{8-6}$ Subtract the exponents.
$= 12^2$
$= 144$

g) $(5^2)^6 \div (5^3)^4 = 5^{2 \times 6} \div 5^{3 \times 4}$ Use the power of a power law.
$= 5^{12} \div 5^{12}$ Use the exponent law for quotients.
$= 5^{12-12}$ Subtract the exponents.
$= 5^0$
$= 1$

15. a) $(3^2 \times 2^2)^3 = (6^4)^3$ The student multiplied the bases and multiplied the powers.
Correct solution:
$(3^2 \times 2^2)^3 = 3^{2 \times 3} \times 2^{2 \times 3}$
$= 3^6 \times 2^6$
$= 729 \times 64$
$= 46\ 656$

b) $[(-3)^2]^3 = (-3)^5$ The student added the exponents instead of multiplying them.
Correct solution:
$[(-3)^2]^3 = (-3)^{2 \times 3}$
$= (-3)^6$
$= 729$

c) $\left(\frac{6^2}{6^1}\right)^2 = 6^4$ The student may have thought that 6^1 is 1.
Correct solution:
$\left(\frac{6^2}{6^1}\right)^2 = (6^{2-1})^2$
$= (6^1)^2$
$= 6^{1 \times 2}$
$= 6^2$
$= 36$

d) $(2^6 \times 2^2 \div 2^4)^3 = (2^3)^3$ The student did not simplify the powers in the brackets correctly.

Correct solution:

$(2^6 \times 2^2 \div 2^4)^3 = (2^{6+2} \div 2^4)^3$
$= (2^8 \div 2^4)^3$
$= (2^{8-4})^3$
$= (2^4)^3$
$= 2^{4 \times 3}$
$= 2^{12}$
$= 4096$

e) $(10^2 + 10^3)^2 = (10^5)^2$ The student used the exponent law for the power of a product inside the brackets, instead of adding the powers.

Correct solution:

$(10^2 + 10^3)^2 = (100 + 1000)^2$
$= 1100^2$
$= 1\ 210\ 000$

16. Use the exponent laws to simplify first.

a) $(4^2 \times 4^3)^2 - (5^4 \div 5^2)^2 = (4^{2+3})^2 - (5^{4-2})^2$ Use the exponents laws for products and quotients.
$= (4^5)^2 - (5^2)^2$ Use the power of a power law.
$= 4^{5 \times 2} - 5^{2 \times 2}$ Multiply the exponents.
$= 4^{10} - 5^4$ Use a calculator.
$= 1\ 048\ 576 - 625$
$= 1\ 047\ 951$

b) $(3^3 \div 3^2)^3 + (8^4 \times 8^3)^0 = (3^{3-2})^3 + 8^0$ Use the exponent laws for quotients and products.
$= (3^1)^3 + 8^0$ Use the power of a power law.
$= 3^{1 \times 3} + 8^0$ Multiply the exponents.
$= 3^3 + 1$
$= 27 + 1$
$= 28$

c) $(2^3)^4 + (2^4 \div 2^3)^2 = 2^{3 \times 4} + (2^{4-3})^2$ Use the power of a power law and the exponent law for quotients.
$= 2^{12} + (2^1)^2$ Use the power of a power law.
$= 2^{12} + 2^{1 \times 2}$ Multiply the exponents.
$= 2^{12} + 2^2$
$= 4096 + 4$
$= 4100$

d) $(6^2 \times 6^0)^3 + (2^6 \div 2^4)^3 = (6^{2+0})^3 + (2^{6-4})^3$ Use the exponent laws for products and quotients.
$= (6^2)^3 + (2^2)^3$ Use the power of a power law.
$= 6^{2 \times 3} + 2^{2 \times 3}$ Multiply the exponents.
$= 6^6 + 2^6$ Use a calculator.
$= 46\ 656 + 64$
$= 46\ 720$

e) $(5^3 \times 5^3)^0 - (4^2)^2 = 5^0 - 4^{2 \times 2}$ Use the zero exponent law and the power of a power law.
$= 1 - 256$
$= -255$

f) $(10^5 \div 10^2)^2 + (3^3 \div 3^1)^4 = (10^{5-2})^2 + (3^{3-1})^4$ Use the exponent law for quotients.
$= (10^3)^2 + (3^2)^4$ Use the power of a power law.
$= 10^{3 \times 2} + 3^{2 \times 4}$ Multiply the exponents.
$= 10^6 + 3^8$ Use a calculator.
$= 1\ 000\ 000 + 6561$
$= 1\ 006\ 561$

19. Use the exponent laws to simplify first, where appropriate.

a) $(2^3 \times 2^6)^2 - (3^7 \div 3^5)^4 = (2^{3+6})^2 - (3^{7-5})^4$ Use the exponent laws for products and quotients.
$= (2^9)^2 - (3^2)^4$ Use the power of a power law.
$= 2^{9 \times 2} - 3^{2 \times 4}$ Multiply the exponents.
$= 2^{18} - 3^8$ Use a calculator.
$= 262\ 144 - 6561$
$= 255\ 583$

f) Multiply in the first set of brackets. Use the power of a power law in the second set of brackets and the exponent law for quotients in the third set of brackets.
$[(-5) \times (-4)]^3 + [(-6)^3]^2 - [(-3)^9 \div (-3)^8]^5$
$= 20^3 + (-6)^{3 \times 2} - [(-3)^{9-8}]^5$ Multiply and subtract the exponents.
$= 20^3 + (-6)^6 - [(-3)^1]^5$ Use a calculator.
$= 8000 + 46\ 656 - (-243)$
$= 8000 + 46\ 656 + 243$
$= 54\ 899$